IMPACT: International Journal of Research in Applied,
Natural and Social Sciences (IMPACT: IJRANSS)
ISSN(E): 2321-8851; ISSN(P): 2347-4580
Vol. 2, Issue 7, Jul 2014, 107-112

MATHEMATICAL MODELLING FOR WATER QUALITY OF NATHSAGAR RESERVOIR, AURANGABAD

N. N. BANDELA & S. M. KOSEY

Department of Environmental Science, Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad, Maharashtra, India

ABSTRACT

Water is one of the most important and basic natural resources. Water resources globally are gradually getting contaminated by the addition of foreign materials from the surroundings. These include organic matter of plant and animal origin, land surface washings besides industrial and sewage effluents. The addition of these materials not only influences the micro fauna of fresh water but also favours the development of a variety of new biota, rendering it unfit for human consumption. Unpolluted safe drinking water is one of the primary requisites for healthy human life. This paper deals with mathematical modelling for water quality of Nathsagar Reservoir located at Aurangabad district, Maharashtra.

Three sampling stations were selected and water samples were collected for a period of one year continuously i.e. June 2009 to May 2010. Monthly changed in physico-chemical parameters were recorded such as Temperature, pH, Electrical Conductivity, Dissolved Oxygen and Biochemical Oxygen Demand respectively. During investigation these parameters were shown some variations with respect to DO concentration. These variations were represented as mathematical models by using multiple linear regression analysis. These models were found to be fit for DO variable in combination with four parameters. Results showed that there is significant relation between DO and other four selected parameter which explains between 45% to 74%.

KEYWORDS: DO, Physico-Chemical Parameters, Mathematical Model, Multiple Linear Regression (MLR), Nathsagar Reservoir

INTRODUCTION

Water is one of the most important and basic natural resources. Water is not only one of the most essential commodities of our day-to-day life, but the development of this natural resource also plays a crucial role in economic and social development processes. Water resources globally are gradually getting contaminated by the addition of foreign materials from the surroundings. These include organic matter of plant and animal origin, land surface washings besides industrial and sewage effluents. The addition of these materials not only influences the micro fauna of fresh water but also favours the development of a variety of new biota, rendering it unfit for human consumption. Unpolluted safe drinking water is one of the primary requisites for healthy human life. Societies have struggled to control water resources, human migrations have been made to obtain water resources, and litigation is commonly used to resolve conflicting water needs (Stephen et. al., 2002).

Modelling is a little like art in the words of Pablo Picasso. It is never completely realistic; it is never the truth. But it contains enough of the truth, hopefully and enough realism to gain understanding about environment systems.

The two primary reasons to conduct modelling are 1) to better understand physical, chemical and biological processes and 2) to develop model capable of realistically representing surface waters, so that the models can be used to support water quality management and decision-making. There is not a complete agreement among the professionals regarding the 'best' approach to modelling rivers, lakes, estuaries and coastal waters.

Rivers are vital and vulnerable freshwater systems that are critical for the sustenance of all life. Rivers are waterways of strategic importance across the world, providing main water resources for domestic, industrial, and agricultural purposes (Faith, 2006). Fresh water represents a very small part of the total water on the earth. Fresh water has become a critical natural resource due to number of reasons. The increasing demand of fresh water in all the sectors like drinking, agriculture, aquaculture and industrial (Ghorade I.B. 2013). The objective of present work is to provide a mathematical modelling approach to study the hydrochemistry of water.

The present study involves the analysis of water particularly on physico-chemical parameters of Nathsagar Reservoir which is one of the major irrigation project in Maharashtra State. It has been constructed across the river Godavari a major in Southern India. Nathsagar is also known as Jayakwadi Reservoir which is situated in (19^0 30^0 N, 75^0 20^0 E) Aurangabad District, 180 Km north east of pune, Maharashtra. The catchments area of Nathsagar Reservoir is 21750 Km^2 and impounding gross storage of dam is 2909 million cubic meters. The submerge area of dam is 35000Ha. The maximum height of this dam is 37 meter. This project has rehabilitated 107 villages. Nathsahar is one of the largest shallow wetland habitat which was traced by the migratory birds from 10-12 year ago.

MATERIAL AND METHODS

The water samples from Nathsagar Reservoir were collected from three different stations viz., Site A, Site B and Site C in the morning hours in a polythene bottle at every forthnight regularly. Every month for a period of one year. These samples were immediately brought to laboratory with all necessary precaution measures as per standard APHA sampling techniques.

The parameters, like water temperature and pH were recorded at the site itself by thermometer & pocket digital pH meter. While other parameters like electrical conductivity, dissolved oxygen and biochemical oxygen demand were estimated in the laboratory as per APHA 1985 Standard Procedure.

Statistical Analysis

The relation between DO concentration and measured parameters were done by multiple linear regression (MLR) analysis.

Table 1: Shows Physico-Chemical Analysis of Site A from Jun 2009 to May 2010

Month	Temp °C	Cond.	Ph	DO	BOD
Jun.09	29.1	298	7.8	7.5	5.1
July.09	28.1	341	7.2	7.2	3.9
Aug.09	29	318	7.1	6.9	4.1
Sep.09	30.1	304	6.6	6.5	4.2
Oct.09	29.1	320	6.4	5.9	4.5
Nov.09	30.1	301	6.3	5.7	4.2
Des.09	30.1	286	6.3	4.9	4.8
Jan.10	28.2	310	6.4	6.1	4.9
Feb.10	28	310	6.8	6.4	4.8

Table 1: Contd.,

Mar.10	30.1	302	6.9	6.8	4.6
Apr.10	33	281	6.5	7.2	4.9
May.10	33.9	352	6.8	7.6	4.8

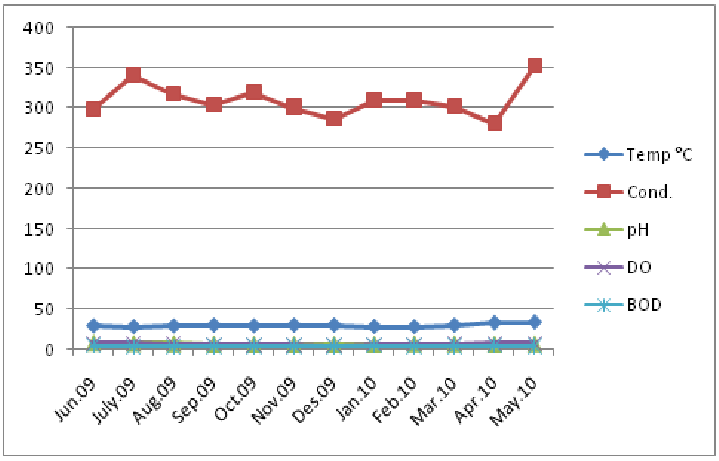


Figure 1: Shows Physico-Chemical Analysis of Site A from Jun 2009 to May 2010

Table 2: Shows Physico-Chemical Analysis of Site B from Jun 2009 to May 2010

Month	Temp °C	Cond.	Ph	DO	BOD
Jun.09	28.1	293	7.8	7.4	4.9
July.09	29.6	299	8.2	7.1	4.6
Aug.09	29.2	300	7.9	6.9	4.2
Sep.09	31.1	312	7.1	6.8	4.3
Oct.09	30.6	304	6.9	5.8	4.1
Nov.09	29.7	312	6.7	5.6	4.3
Des.09	29.3	314	6.6	5.1	4.5
Jan.10	28.4	286	6.2	6.4	4.9
Feb.10	27.8	292	7.2	6.3	4.2
Mar.10	32.3	306	6.8	6.9	4.6
Apr.10	33.1	321	6.7	7.3	3.9
May.10	35.1	314	6.9	7.2	3.8

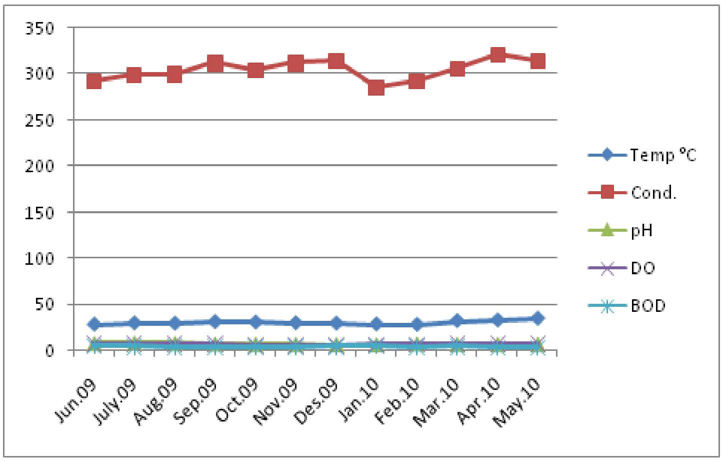
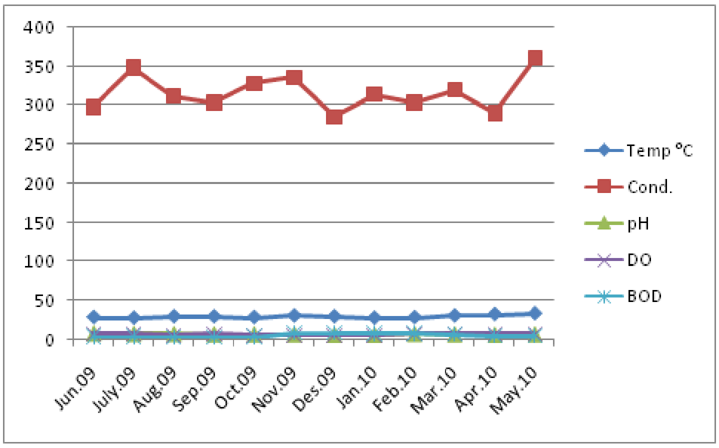


Figure 2: Shows Physico-Chemical Analysis of Site B from Jun 2009 to May 2010

Table 3: Shows Physico-Chemical Analysis of Site C from Jun 2009 to May 2010

Month	Temp °C	Cond.	Ph	DO	BOD
Jun.09	29.1	298	7.9	7.1	3.5
July.09	28.1	348	7.5	6.9	3.8
Aug.09	30.1	312	7.2	6.2	3.1
Sep.09	30	304	6.9	6.8	3.2
Oct.09	29.1	328	6.9	5.4	3.8
Nov.09	31.1	336	6.9	5.9	8.1
Des.09	30.1	286	6.3	5.3	8.3
Jan.10	28.2	314	6.2	5.8	7.9
Feb.10	28.9	304	7.1	6.8	7.5
Mar.10	31.1	320	6.9	6.7	6.9
Apr.10	33.1	290	6.3	7.2	4.9
May.10	34.1	360	6.9	7.3	4.1



Note: DO and BOD parameters are in mg/l except Temperature, pH and EC
Temperature is expressed in degree centigrade, EC in µS/cm
The value represents the monthly values of the respective data
DO - Dissolved oxygen, BOD – Bio-chemical Oxygen Demand

Figure 3: Shows Physico-Chemical Analysis of Site C from Jun 2009 to May 2010

In order to understand about variables which influence the DO during work, a number of physico-chemical parameters were analyzed. These factors exhibited considerable seasonal and spatial variations due to changes in environment conditions of riverine systems. Generally, multiple linear regression (MLR), may lead to incorrect identification of most the predictor due to collinearity between the input variables (Thompson et al., 2001). MLR also allows the reduction of the dimensionality of non-linear data set by correction amongst a large number of variables in terms of underlying factors without neglecting any information from the original data set (Juahir et al., 2004). Although linear regression was one of the oldest statistical modeling techniques, their applications were still widely used in many linear relationships works. Despite the fact that many studies performed concluded that there is no general best modeling techniques, it still depends on the scope and objectives of the studies (Aertsen et al., 2010). Therefore multiple linear regression analysis was performed on the DO considering these variables are independent.

DISCUSSIONS AND CONCLUSIONS

All results acquired of water quality parameters measurements are presented in (Table 1, 2 & 3). During investigation we have developed a model, based on MLR i.e. multiple linear regression. The multiple regression analysis was used to obtain a linear equation for estimating of DO concentration. All equations showed correlation between DO concentration with four measured parameters.

The identified model for DO at site A for the year 2009-2010 was

DO = 0.213 (Temp) + 0.0082 (EC) + 1.217 (pH) – 0.29 (BOD) – 9.059

(R^2= 0.7395)

This model explains 74 % of variations in distribution of DO at site A. Though the model is significant, the variable BOD do not have significant contribution except temperature, EC (Electrical Conductivity) and pH during the year 2009-2010.

The identified model for DO at site B for the year 2009-2010 was

DO = 0.345 (Temp) - 0.037 (EC) + 0.713 (pH) + 0.466 (BOD) + 0.382

(R^2= 0.6527)

This model explains 65 % of variations in distribution of DO at site A. Though the model is significant, the variables EC (Electrical Conductivity) do not have significant contribution except temperature, pH and BOD (Biochemical oxygen demand) during the year 2009-2010.

The identified model for DO at site C for the year 2009-2010 was

DO = 0.0213 (Temp) - 0.004 (EC) + 0.77 (pH) – 0.044 (BOD) -3.955

(R^2= 0.4466)

The combination of four identified parameters failed to explain the distribution of DO at site C during the year 2009-2010, though the model statistically significant and explains for 45% of variability.

The multiple linear regression models were found fit for DO (Dissolved Oxygen) and the combination of four factors explained between 45% to 74% of variations in the distribution of DO during the year June 2009- May 2010 of Nathsagar Reservoir. All these models indicate that during the period of one year the variability among the models decreases from site A to Site C which indicate that although the selected parameters significantly affect the distribution of DO, there exist some other factors also that influence the DO concentration at site A, Site B and Site C. In the present study it was found that the model was statistically rigorous at site A and B which shows nearly 74% and 65% variability in DO concentrations could be described by temperature, EC, pH and BOD.

It indicate that Site A and B was not so polluted but whereas at site C the model explains only 45% variability. It may be due to mixing of large quantities of agricultural and municipal wastewater enters it through drains and nallahs. The water quality of Nathsagar reservoir at site C has been deteriorated and the potable nature of water is being lost. Therefore continuous monitoring and treatment process is required if the water is to be used for drinking purposes. This study would help the water quality monitoring, management in order to improve the quality of water with maintaining better sustainable management and to develop awareness programs need to educate among the local people to maintain the quality of the river waters and its surroundings.

REFERENCES

1. Aertsen W., Kint V., Orshoven J.V., Ozkan K., Muys B.(2010): Comparison and ranking of different modelling techniques for prediction of site index in mediterranean mountain forests. Ecol Model, 221, 1119–1130.
2. APHA (1985) Standard methods for examination of water and waste water, 20th Edition, American Public Health association, Washington, D.C.
3. Faith Ngwenya, (2006): Water Quality Trends in the Eerste River, Western Cape, 1990-2005. A mini thesis submitted in partial fulfilment of the requirement for the degree of Magister Scientiae, Integrated Water resources management in the Faculty of Natural Science, University of the Western Cape.pp.41.
4. Ghorade, I.B. (2013). *Eco sustainability Assessment of Godavari river water for stainable Utilization*. Ph.D. Thesis, Dr. B.A.M. University, Aurangabad.
5. Juahir H., Zain S.M., Toriman M.E., Mokhtar M., Man H.C.(2004): Application of artificial network models for predicting water quality index. *Journal Kejuruteraan Awam* 16:42–55.
6. Stephen J. Vandas, Thomas C. Winter, William A. Battaglin (2002): Water and the Environment. Page 7- 12 American Geological Institute, 4220 King Street Alexandria, VA 22302.
7. Thompson M.L., Reynolds J., Cox L.H., Guttorp P, Sampson P.D. (2001): A review of statistical methods of the meteorological adjustment of tropospheric ozone. Atmos Environ. 35:617–630.